Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 455

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. PROFESSIONAL PAPER December 2, 1916

THE DRYING FOR MILLING PURPOSES OF DAMP AND GARLICKY WHEAT.

By J. H. Cox,

Assistant in Charge of the United States Grain-Standardization Laboratory at Baltimore, Md.

CONTENTS.

	Page.
Introduction	1
The drying of damp wheat	2
The distribution of garlic	2
The amount of moisture in garlic before and after drying	3
The loss of moisture in garlic in warm and in hot wheat	4
The quantity of garlic before and after cleaning	4
Tempering the dried wheat	5
Commercial milling test	5
Drying and milling tests of garlicky wheats having a high, medium, and low moisture content	6
Drying wheat at different temperatures	7
The drying of wheat at 140° F	9
Summary	9

INTRODUCTION.

In connection with investigations to determine the best method of artificially drying, cleaning, and handling garlicky wheat for milling purposes, data were obtained to show the proper temperature at which wheat should be dried for milling purposes. The results cover both the drying of garlicky wheat and the drying of damp wheat that is free from garlic. The milling and baking tests of the wheat used in the various experiments were made by L. M. Thomas, Assistant in Charge of the United States Grain-Standardization Laboratory at Agricultural College, N. Dak.

The artificial drying of wheat facilitates the removal of the garlic bulblets by subsequent cleaning. It is a process that can be used to best advantage by mills. Experiments pertaining to the removal of garlic from wheat after artificial drying were first described by

Dr. J. W. T. Duvel.[1] The first step consists in reducing the moisture content of the wheat to a relatively low percentage, after which approximately all of the garlic can be removed by thorough cleaning. Although even by this process it is impossible to remove absolutely all of the garlic bulblets, flour commercially free from the odor of garlic can be manufactured if it is carefully handled. This method is most practicable for flour mills, in that the large amount of moisture lost in drying can be largely replaced by properly tempering the wheat before milling.

THE DRYING OF DAMP WHEAT.

A car of damp wheat containing a moisture content of 16.3 per cent was dried down to 12.9 per cent in a commercial drier. This wheat was dried for one hour at a temperature of approximately 140° F. before being dropped into the cooling compartment of the drier. Representative samples of 5 bushels each were taken from this lot of wheat before and after drying for experimental milling and baking tests.

The results of the baking tests with the straight flours made from these samples and from mixtures of equal portions thereof are given in Table I.

TABLE I.—*Results of baking tests with flour made from natural and dried wheats and from a mixture of both.*

Description of samples.	Water absorption of flour.	Volume of loaf.	Score.		Remarks concerning crumb.
			Texture of loaf.	Color of crumb.	
	Per cent.	*C. c.*			
Wheat, natural[1]	56.8	2,101	92.0	97.3	A little gray.
Wheat, dried at 140° F.[1]	56.5	2,085	91.6	95.9	Do.
Wheat mixture, equal quantities of above	56.2	2,070	91.6	95.3	Do.

[1] Average of two tests.

Table I shows the results of the baking tests of flour made from the wheat before and after drying. The differences are in every case found to be very slight and within the range of experimental error. When correlated with the tests that follow, these results indicate that 140° F. is the proper temperature at which to dry damp wheat.

THE DISTRIBUTION OF GARLIC.

Wild garlic is a native of western Europe and was probably introduced into the United States early in the eighteenth century. As early as 1754 garlic was quite common in wheat in parts of Pennsylvania.[1]

---

[1] Garlicky wheat. *In* U. S. Dept. Agr., Bur. Plant Indus. Bul. 100, p. 21–30, pl. 1–2. 1907.

The wild onion, or garlic (*Allium vineale*), is found in the Atlantic coast region from Massachusetts to Georgia and as far inland as Missouri (fig. 1), and in a large part of that territory it is the worst weed pest.[2]

THE AMOUNT OF MOISTURE IN GARLIC BEFORE AND AFTER DRYING.

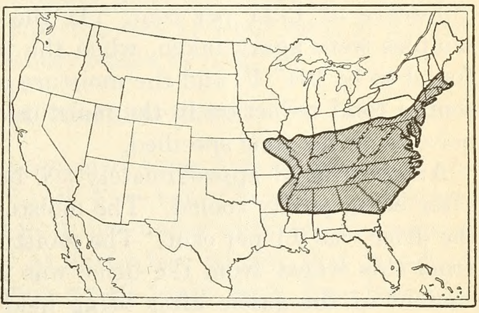

FIG. 1.—Sketch map of the United States, showing the distribution of the wild onion, or garlic.

Seven different lots of garlicky wheat, aggregating about 50,000 bushels, were followed through a commercial drier in order to note the effect of the different operations on the garlic in the wheat. Several samples of each lot of wheat were taken before going into and after coming out of the drier. The garlic was separated from each of these samples and the moisture content determined by drying to constant weight in a water-bath oven. The maximum amount of water in the garlic before drying was 41.74 per cent and the minimum 25.85 per cent, while the average was 37.92 per cent. The maximum amount of water found in the garlic after drying was 29.73 per cent and the minimum 18.15 per cent, with an average of 23.41 per cent. The average reduction in the moisture content of the garlic during the drying was 14.51 per cent. The average reduction in the moisture content of the wheat was 5.1 per cent, the average moisture of the wheat before drying being 13.9 per cent and after drying 8.8 per cent.

A great many of the garlic bulblets from the dried wheat were found to contain considerable moisture after a severe drying, while other bulblets from the same lot were shriveled and brittle. This was caused in part, no doubt, by the fact that the hot air was not equally distributed to every particle of wheat and garlic in the drier, and probably also by the fact that the garlic was in different stages of maturity, some of the bulblets when they went into the drier containing much less moisture than others.

---

[1] Pipal, F. J. Wild garlic and its eradication. Ind. Agr. Exp. Sta. Bul. 176, 43 p., 16 fig., 8 pl. 1914.

[2] See Cox, H. R., Wild onion: Methods of eradication, U. S. Dept. Agr., Farmers' Bul. 610, 8 p., 7 fig. 1914.

THE LOSS OF MOISTURE IN GARLIC IN WARM AND IN HOT WHEAT.

One lot of about 500 bushels of hot wheat was run into a bin directly from the heating chamber of the drier without cooling, in order to note the effect of hot wheat on the garlic. The temperature of the air in the drier during the drying of this lot of wheat was 180° F. Five samples of this hot wheat were placed in thermos bottles, and the temperature of the wheat was found to range from 140° to 154°, with an average of 148° F. The moisture content of this dried wheat ranged from 8.2 per cent to 8.8 per cent, with an average of 8.5 per cent. The moisture of the garlic taken from the drier was found to be 27.4 per cent. After the wheat had been in the bin for 48 hours the temperature decreased to 114° F. and the moisture content of the garlic was reduced from 27.4 per cent to 14.23 per cent, a difference of 13.17 per cent. At the end of 5 days and 22 hours samples were again taken, when the temperature of the wheat was found to be 104° F. and the moisture content of the garlic 11.04 per cent, a total reduction in the moisture content of the garlic of 16.36 per cent in the time specified.

Another lot of approximately 500 bushels was run from the drier after being partly cooled. The moisture content of this wheat from the drier was 9.1 per cent. The moisture content of the garlic taken from this wheat from the drier was 26.25 per cent. The moisture content of the garlic after being held for 70 hours in the bin was 20.34 per cent, a reduction of 5.91 per cent. The wheat at the end of 70 hours was still warm, the temperature being 106° F.

Wheat dried to a moisture content of 8 or 9 per cent will not deteriorate or start fermentation if left in a bin warm. This method assists in removing the moisture from the garlic, which in turn makes the garlic lighter and more easily removed from the wheat.

THE QUANTITY OF GARLIC BEFORE AND AFTER CLEANING.

The average quantity of garlic in this wheat before drying was 14 one-hundredths of 1 per cent, and the average quantity of garlic in the wheat from the drier was 13 one-hundredths of 1 per cent. The average quantity of garlic in the wheat going to the rolls after a very thorough cleaning was 3 one-hundredths of 1 per cent, which is equivalent to approximately eight or ten dried garlic bulblets in each pound of grain. This quantity of garlic in wheat, if taken in its natural state, when the bulblets are hard and firm, has been found to impart a slight garlicky odor to the flour. Fortunately, however, the drying process changes the strong pungent odor of garlic to a milder one, so that it requires a higher percentage of dried garlic to affect the odor of the flour.

TEMPERING THE DRIED WHEAT.

Considerable care should be taken in tempering wheat artificially dried to a low moisture content. Ordinarily one tempering will not be sufficient to bring the moisture content of the wheat back to the normal amount for good milling. For the best results the wheat should be held in the bin at least 24 hours, if not longer, after the last tempering, to allow the water to be more evenly distributed. If the wheat is handled after it is tempered and then held in the bin for several hours, the wet and the dry lots will be more thoroughly mixed and the moisture uniformly distributed, thus making a more even mixture at the rolls.

The average moisture content of seven different lots of wheat going to the drier was 13.9 per cent and the average moisture content after drying was 8.8 per cent. The average moisture content of the dried wheat at the rolls after one tempering was 11.4 per cent, or 2.5 per cent below that of the natural wheat before drying.

COMMERCIAL MILLING TEST.

In the commercial milling experiment three cars of wheat, or approximately 3,000 bushels, were very thoroughly mixed. This wheat had a small quantity of garlic in it, but under ordinary commercial practices it would be classified as garlic-free wheat; that is, wheat which after a thorough cleaning would make flour free from the odor of garlic.

The moisture of the wheat going into the drier in this experiment, as shown in Table II, was 13.6 per cent, and that to the bin from the drier 8.1 per cent. The moisture of the natural wheat at the rolls was 13.2 per cent and of the dried wheat at the rolls after one tempering 11.9 per cent, a difference of 1.3 per cent.

Table II.—*Moisture content of natural and dried wheats, the average number of garlic bulblets per pound of wheat milled, the average percentage at the rolls, and the odor of the flour.*

Description of sample.	Moisture of wheat as milled.	Garlic at the rolls.		Odor of the flour.
		Bulblets per pound.	Per cent.	
	Per cent.			
Natural wheat	13.2	8.6	0.035	Garlicky.
Dried wheat	11.9	5.0	.019	Natural, except 3 per cent of lowest grade.

The dried wheat made flour 97 per cent of which was free from the odor of garlic, while all of the flour made from the natural wheat had a garlicky odor. The odor of garlic when present always is more pronounced in the low-grade flours. In the foregoing test the flour made from the dried wheat gave only 3 per cent classed as garlicky, which was the lowest grade, while the flour made from the natural wheat was 100 per cent garlicky. The rolls receiving garlicky wheat, whether dried or natural, will have to be washed frequently, for the garlic bulblets eventually gum the rolls to such an extent as to give the flour the odor of garlic.

DRYING AND MILLING TESTS OF GARLICKY WHEATS HAVING A HIGH, MEDIUM, AND LOW MOISTURE CONTENT.

Table III shows the results from three different lots of wheat having a low, medium, and high moisture content, respectively, which were dried at a temperature fluctuating from 190° to 200° F. The low-moisture or dry wheat contained 12.7 per cent and the medium-dry wheat 13.9 per cent of water, while the high-moisture wheat contained 16.6 per cent. Each lot was dried the same length of time (one hour) and at the same temperature as nearly as practicable. Two bushels of wheat were taken from each lot, both before and after drying, and a milling and baking test was made of each lot in order to note the effect of drying.

Table III also shows the results of baking tests with flour made from these three lots of wheat of low, medium, and high moisture content dried at a temperature of 190° to 200° F.

Table III.—*Moisture content of wheat before and after drying for one hour at temperatures ranging from 190° to 200° F., and the results of baking tests of flour made therefrom.*

Lot No.	Moisture content (per cent).		Baking results (average of two tests)—					
	Before drying.	After drying.	Sample of flour from wheat—	Water absorption.	Volume of loaf.	Score.		Remarks concerning crumb.
						Texture of loaf.	Color of crumb.	
				Per cent.	*C. c.*			
1, low moisture	12.7	8.0	Before drying	56.0	1,885	91.2	94.2	Creamy.
			After drying	56.2	1,879	93.0	96.0	Do.
2, medium moisture	13.9	....	Before drying	55.3	1,937	91.7	97.7	Do.
			After drying	55.4	1,856	90.0	97.7	Do.
3, high moisture	16.6	9.3	Before drying	56.0	2,026	95.0	96.0	Do.
			After drying	55.9	1,928	93.5	96.0	Do.

From these data it appears that more injury is done to the flour by drying wheat having a high moisture content at a temperature of 190° to 200° F. than in drying wheat with a low moisture content. The decrease in loaf volume of the wheat having a moisture content of 16.6 per cent was 98 c. c., or 4.83 per cent, and the decrease in the loaf volume of the wheat having a moisture content of 13.9 per cent was 81 c. c., or 4.17 per cent. The decrease in the loaf volume of the wheat with a moisture content of 12.7 per cent was only 6 c. c., or 0.03 per cent. The texture of the loaf was injured in the wheats having a high or a medium moisture content, but it was slightly superior in the low-moisture wheat. In these tests an injury was done to the wheats having a medium or a high moisture content (fig. 2) in the process of drying at a temperature of 190° to 200° F., but none was noticed in the low-moisture wheat.

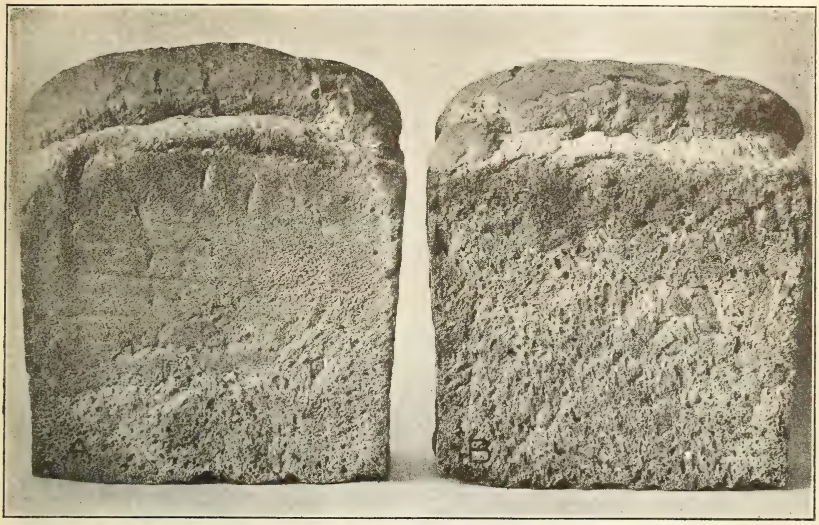

Fig. 2.—Loaves from natural wheat and from wheat artificially dried: *A,* Loaf from natural wheat, with a volume of 2,050 c. c. and a texture of 95; *B,* loaf from wheat dried at a temperature of 190° to 200° F., with a volume of 1,946 c. c. and a texture of 93.5. The moisture content of the natural wheat was 16.6 per cent.

DRYING WHEAT AT DIFFERENT TEMPERATURES.

Table IV shows the results of tests before and after drying 6,000 bushels of wheat, the temperature of the hot air in the drier at the time these tests were made, the length of time the wheat was in the drier, and the moisture of the wheat going into the rolls. The wheat was divided into four different lots of approximately 1,500 bushels each. One lot of the natural wheat was milled as such, and the other three lots were milled after being dried at temperatures of 140°, 160°, and 180° F.

Baking tests were made from the flour milled from the wheat dried at these different temperatures and the results are also shown in Table IV.

TABLE IV.—*Moisture content of wheat dried at different temperatures and the results of baking tests of flour made therefrom.*

Description of sample of wheat.	Moisture content (per cent).			Length of time in drier.	Baking tests of flour.				
	Before drying.	After drying.	At rolls.		Water absorption.	Volume of loaf.	Score.		Remarks concerning crumb.
							Texture of loaf.	Color of crumb.	
				Hours.	Per cent.	C. c.			
Natural	13.3		13.4		55.9	2,003	94.0	100	Slightly gray.
Dried at—									
140° F	13.5	8.9	12.8	1⅔	56.2	2,050	93.0	97	A little gray.
160° F	13.7	8.4	13.3	1½	55.9	2,040	93.5	97	Do.
180° F	13.4	7.3	10.5	1⅓	55.9	1,933	92.5	95	Gray.

There was not very much difference between the bread made from the natural wheat and that from wheat dried at 140° and 160° F. The bread made from the wheat dried at 180° F. was slightly inferior (fig. 3). The loaf made from the natural wheat had a smaller volume than either of the loaves from the wheat dried at 140° and 160° F., but had a slightly better texture and color. These differences can easily be attributed to the nature of the test and are within the range of experimental error. Moreover, it is extremely difficult to mix 6,000 bushels of wheat (four cars in this case) in such a manner that samples of the flour taken during the process of milling will give exactly duplicate results in a baking test. The differences obtained from these three lots might have been due to actual differences in the samples, which are likely to be found in tests of this kind.

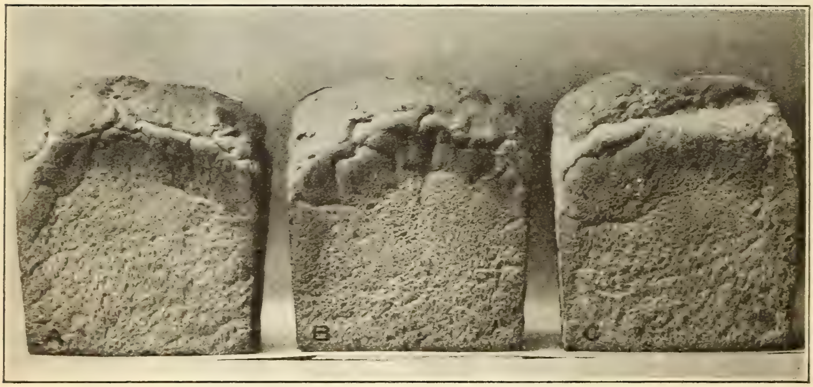

FIG. 3.—Loaves of bread from natural wheat, from wheat dried at 180° F., and from wheat dried at 140° F.: *A*, Bread from natural wheat, with a loaf volume of 2,003 c. c. and a texture of 100; *B*, bread from wheat dried at 180° F., with a loaf volume of 1,933 c. c. and a texture of 95; *C*, bread from wheat dried at 140° F., with a loaf volume of 2,050 c. c. and a texture of 97.

THE DRYING OF WHEAT AT 140° F.

Three different lots of wheat were dried at a temperature of 140° F. and a 2-bushel sample was taken before and after drying, a milling and baking test being made of each. The wheat was subjected to the heat in the drier for 1 hour and 40 minutes. The results of the drying and of the baking tests of these three lots of wheat before and after drying at approximately 140° F. are shown in Table V.

TABLE V.—*Moisture content of wheat before and after drying for 1⅔ hours at a temperature of approximately 140° F., and the results of baking tests of flour made therefrom.*

Lot No.	Moisture content.		Temperature of hot air (° F.).			Baking tests.					
	Before drying.	After drying.	Maximum.	Minimum.	Average.	Sample of flour from wheat—	Water absorption.	Volume of loaf.	Score.		Remarks concerning crumb.
									Texture of loaf.	Color of crumb.	
	P. ct.	*P. ct.*					*P. ct.*	*C. c.*			
1	13.3	9.0	156	130	143	Before drying	59.7	2,097	89.0	94.0	Creamy gray.
						After drying	58.8	2,130	91.3	95.0	Creamy.
2	13.7	9.8	154	132	141	Before drying	58.8	2,027	90.0	92.3	Creamy gray.
						After drying	59.1	2,143	90.0	95.0	Creamy.
3	13.7	9.2	150	128	141	Before drying	59.1	2,130	90.0	95.0	Do.
						After drying	59.4	2,123	92.0	95.0	Creamy gray.

In the first two lots there was six-tenths of 1 per cent more cockle in the samples as milled before drying than in the sample after drying, and it is possible that the presence of this cockle may have been the cause of the slightly better results from the milling and baking tests after drying than before drying.[1] In the last sample the amount of cockle was about the same before and after drying, and the results with regard to texture and loaf volume are approximately the same.

A number of samples of this wheat were taken as it left the heater division of the drier, placed in thermos bottles, and the temperature recorded. The lowest temperature obtained was 110° and the highest 132° F. The average temperature was 125° F.

SUMMARY.

The results of these investigations show practically no bad effects from the drying of wheat at 140° F. and indicate that this temperature is probably the most satisfactory for the drying of wheat, either with or without garlic, for milling purposes. More extensive experiments may show that wheat can be dried at a higher temperature than 140° F. without having a bad effect on the flour. Every test except one where the wheat was dried at 180° F. and above gave poorer results in the baking test from the standpoint of loaf volume and texture than when dried at 140° F.

---

[1] See Miller, R. C., Milling and baking tests of wheat containing admixtures of rye, corn cockle, kinghead, and vetch, U. S. Dept. Agr. Bul. 328, 24 p., 10 fig. 1915.

If wheat is dried down to 9 per cent of moisture or below for the removal of garlic, great care must be taken in tempering it back to the normal amount of moisture. In order to restore the moisture content of the dried wheat to normal, which is important for good milling, the wheat should be tempered at least twice, and more if necessary. After the wheat is tempered it should be stored several hours before mixing or before another tempering is made, in order to allow the moisture to penetrate into the kernel. Several hours after the last tempering the wheat should be run from the bin and a thorough mixture made. This last process assists in mixing the dry and wet spots and makes a more even mixture at the rolls.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE RELATING TO WHEAT.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

Alaska and Stoner, or "Miracle," Wheats: Two Varieties Much Misrepresented. (Department Bulletin 357.)
Cereal Experiments at Dickinson, N. Dak. (Department Bulletin 33.)
The Smuts of Wheat, Oats, Barley, and Corn. (Farmers' Bulletin 507.)
Durum Wheat. (Farmers' Bulletin 534.)
The Culture of Winter Wheat in the Eastern United States. (Farmers' Bulletin 596.)
Winter-Wheat Varieties for the Eastern United States. (Farmers' Bulletin 616.)
Growing Hard Spring Wheat. (Farmers' Bulletin 678.)
Varieties of Hard Spring Wheat. (Farmers' Bulletin 680.)
Marquis Wheat. (Farmers' Bulletin 732.)
Hard Wheats Winning Their Way. (Separate 649, from Yearbook, 1914.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Experiments with Wheat, Oats, and Barley in South Dakota. (Department Bulletin 39.) Price, 10 cents.
Spring Wheat in the Great Plains Area: Relation of Cultural Methods to Production. (Department Bulletin 214.) Price, 10 cents.
Milling and Baking Tests of Wheat Containing Admixtures of Rye, Corn, Cockle, Kinghead, and Vetch. (Department Bulletin 328.) Price, 10 cents.
The Commercial Status of Durum Wheat. (Bureau of Plant Industry Bulletin 70.) Price, 10 cents.
Improving the Quality of Wheat. (Bureau of Plant Industry Bulletin 78.) Price, 10 cents.
Garlicky Wheat. (Bureau of Plant Industry Bulletin 100, part 3.) Price, 5 cents.
Improvement of the Wheat Crop in California. (Bureau of Plant Industry Bulletin 178.) Price, 10 cents.
Handling Wheat from Field to Mill. (Bureau of Plant Industry Circular 68.) Price, 5 cents.
Winter Wheat in Western South Dakota. (Bureau of Plant Industry Circular 79.) Price, 5 cents.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1916

NATIONAL AGRICULTURAL LIBRARY
1022734408